NOTES ON BRITISH UREDINALES, INCLUDING ONE NEW TO THE BRITISH ISLES

BY

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By W. B. GROVE, M.A. and C. G. C. CHESTERS, M.Sc.

(With Plate XIX and 2 Text-figures)

Of these notes only the last one, on *Melampsorella Symphyti*, is written by the junior author (C. G. C. C.). The others, written by the senior author (W. B. G.), consist mainly of the results of observations due to many correspondents and communicated to him; but he wishes to put on record his great indebtedness to the junior author for the drawings and photographs by which they are illustrated.

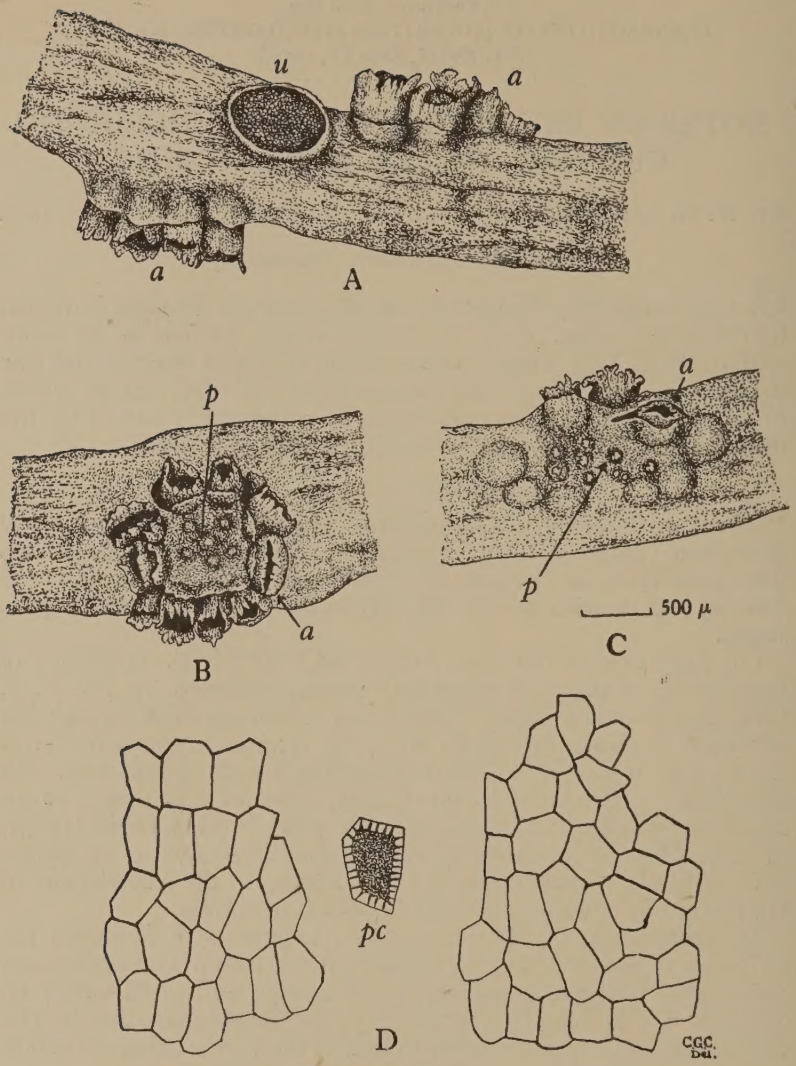
Uromyces sparsus Lév.

This rare Uredine, on *Spergularia*, of which I could say, in my *Rust-Fungi* (1913), p. 111, "I have seen no British specimen," has since been found at Porlock (Mr Norman G. Hadden), at the Farne Islands, and in other places, but only in the uredo- and teleutospore stages.

On June 12th of last year, I received from Mr F. T. Brooks, of Cambridge, a plant of *Spergularia marina*, collected by Mr V. J. Chapman at Scolt Head, Norfolk, on which was the remarkable aecidium described below (Pl. XIX, fig. 1); also on the same leaves were a few uredosori like those previously found on that host. On searching the literature in my library, I found a reference to an aecidium on *Spergularia* in Fragoso's "Uredales" (*Flora Iberica* (1925), p. 106). Here he describes pycnidia and aecidia growing on *Spergularia marginata*, found by Dr P. L. Unamuno in the salt-marshes of Unquera, but nowhere else in the Spanish peninsula.

On comparison of Mr Chapman's specimen with Fragoso's description, it was seen that the agreement was exact. The aecidia are remarkably brilliant in colour, almost scarlet, and could hardly be overlooked, if present, by anyone who was collecting Uredinales. The colour was, in fact, very similar to that of the very striking vermilion caeomata of *Xenodochus carbonarius*.

As will be seen by the appended description and figure (Text-fig. 1 D), the cells of which the peridium of the aecidial cups is composed are not arranged in lines or rows, but without any definite order whatever. This state of things is very unusual and was carefully described by Fragoso. The peridia have much the shape of an ordinary breakfast cup. The uredospores which accompanied the cluster-cups were exactly what they should be (Text-fig. 1 A, *u*). There were no teleutospores then present.



Text-fig. 1

A. Uredo- (*u*) and aecidial-sori (*a*) of *Uromyces sparsus* Lév. on a leaf of *Spergularia marina*. The irregular splitting of the peridium is indicated by the deeply indented margin. B. The aecidia are nearly always formed in a single ring round the area bearing the pycnidia (*p*). At *a* an aecidium on the point of opening shows the characteristic ragged slit in the peridial wall. C. A young aecidial sorus in which most of the aecidia have not yet broken through the epidermis. The pycnidia (*p*) are surmounted by drops of greyish nectar containing the pycnidiospores. D. Two portions of the peridial wall showing the very irregular arrangement of the cells which is responsible for the irregular splitting of the wall at maturity. *pc* represents a single peridial cell, illustrating the deep channels which penetrate its walls.

Description of Uromyces sparsus

Pycnidia amphigenous, dark red, in little clusters surrounded by the aecidia (Text-fig. 1 B and C).

Aecidia in a contiguous series, more or less forming a single circle, 1–2 mm. in diam., around the pycnidial group (Text-fig. 1 B), bright orange-red, almost scarlet when in perfection, nearly cylindrical or cup-shaped, with a much dentated but not recurved white margin; peridial cells firmly united to one another in a thin membrane, polygonal in outline, not arranged in distinct rows but irregularly (Text-fig. 1 D), with a wall about 3 μ thick, 4–5 μ on the outer side, in optical section deeply transversely striate; aecidiospores oval-quadrate, about 20 μ wide.

Uredosori on the leaves, scattered, small, oblong-oval, 0·5–1 mm. long, dark cinnamon, pulverulent. Uredospores roundish oval, with a wall (1–1·5 μ) equally thick all round, scarcely visibly echinulate or quite smooth, brownish yellow, with two to four more or less equatorial pores.

On *Spergularia marina* (=*S. media* Presl), Scolt Head, Norfolk (Mr V. J. Chapman), June, 1933.

In the Herbarium of the Royal Botanic Gardens, Kew, there is a specimen under the name *Uromyces sparsus* Lév., issued in Jaap's *Fungi Selecti* Exsiccati, No. 137*b*, of pycnidia and aecidia on "*Spergularia salina* Presl," gathered at Oldesloe in Schleswig-Holstein in June, 1906, by Chr. Sonder. This agrees with that from Scolt Head, except that it is on a smaller scale; the plants affected are very small (apparently seedlings), and of course the brilliant colours have badly faded. But the arrangement of the pycnidia and aecidia and the structure of the aecidium are exactly the same. Dr Sonder's record of the aecidium is repeated in the *Kryptogamen-flora der Mark Brandenburg* (Klebahn, Band v*a*, pp. 274–5) with figures of the aecidio-, uredo- and teleutospores on p. 280.

Uromyces Scirpi Burr.

This species has now been found in several places in south Britain, in Cornwall, Dorsetshire, Pembrokeshire, Anglesey, Norfolk, etc. It is heteroecious, and its aecidial stage has been known to be on *Glaux maritima* ever since Plowright, in 1890, infected the *Glaux* with germinating teleutospores from *Scirpus maritimus* brought from Paul on the banks of the Humber. At first he thought that it must be a distinct species, to which he gave the name of *U. maritimae* Plowr., but afterwards he satisfied himself that it was the same as *U. lineolatus* Desm., i.e. *Uromyces Scirpi* Burr.

For a long time it has been known that a similar *Uromyces* occurs in other countries on *Scirpus maritimus*, *S. fluviatilis*, and allied species, and that the infested plants were capable of infecting other plants

growing near, such as *Hippuris* and various Umbellifers, viz. *Sium*, *Pastinaca*, *Ferula*, *Daucus*, *Oenanthe aquatica*, etc., and producing aecidia on them.

Last year, 1933, Mr E. A. Ellis, of Gorleston, kindly sent me both the *Uromvces* on *Scirpus* and the *Glaux* from his district where the *Glaux* bears numerous aecidia. But, further, he has carefully examined *Oenanthe aquatica*, *Peucedanum sativum*, *Daucus Carota*, *Sium erectum* and *Hippuris vulgaris*, all growing in the vicinity of the *Scirpus*, some actually touching its leaves and surrounded by aecidium-bearing *Glaux*, yet on the whole of these plants not a single aecidium could be seen.

In October, 1931, Mr C. P. Hurst, of Landulph, near Saltash, Cornwall, found the teleutosori of *Uromyces Scirpi* on *Scirpus maritimus* in the estuary of the Tamar, and sent them to me. In May, 1932, he looked for aecidia on the *Glaux* which grows rather close to the *Scirpus*, but could find none. Then, on May 30th of last year, he came upon abundance of aecidia on plants of *Oenanthe crocata* (Pl. XIX, fig. 2) in the same locality (Kingsmill Lake, an inlet of the estuary), many actually touching the *Scirpus*. When he sent me some of the *Oenanthe* it could be seen that the clusters of aecidia on them were very similar in size and character to those on the *Glaux* from Norfolk. Again, on June 21st he found "Uredosori in profusion on the *Scirpus maritimus* where it was in close association or in actual contact with the infected *Oenanthe*, but not unless." At the same time he could find no aecidia on *Glaux* which was growing near by. Wherever the *Scirpus* was not in association with the *Oenanthe*, he says, it seemed quite free from the rust.

The *Uromyces* from Cornwall is morphologically indistinguishable, in its uredo- and teleutospore stages, from the Norfolk specimens and, as has been said, the aecidia are likewise very similar in colour and in arrangement so far as the difference in size of the two hosts permits, while the spores have the same measurements. There can hardly be any doubt that we have here a little biological sport of the *Uromyces*, infecting the *Oenanthe* capriciously instead of the *Glaux*; the cause of this freakishness, if any, may be beyond the limits of conjecture*. Plurivorous Uredinales are by no means unknown.

A similar case no doubt lies before us in the *Puccinia arenariicola* of Plowright, of which in 1884 Canon Du Port and he found the aecidia on *Centaurea nigra* on the sea-shore at Hemsby, Norfolk, as recorded in *Journ. Linn. Soc. Bot.* XXIV (1888), 90. It is obvious, on reading the descriptions of *Puccinia Schoeleriana* and *P. arenariicola*, that there is

* Since writing these words, I find that R. Maire, in 1909, discovered a similar aecidium on *Oenanthe crocata*, at the mouth of the Orne, Calvados (Normandy), in close association with the *Uromyces* on *Scirpus maritimus*. See Sydow's *Monographia Ured.* II, 306.

hardly a mentionable difference between the two species, except for the aecidial hosts. Mr Ellis, who is familiar with the locality, informs me that the aecidium on *Centaurea* has never been found there again. The explanation seems to lie in the supposition that the formation of the aecidium on that host was an accidental and capricious freak which has never been repeated. But the aecidium of *Puccinia Schoeleriana* on *Senecio Jacobaea* is common at Hemsby, and also *Carex arenaria* with its rust is abundant there. As Mr Ellis reminds us, *Centaurea nigra* is not a usual member of the *Carex arenaria* association; in fact, on June 18th last, he and his brother traversed the Norfolk dunes from Hemsby to Winterton, and in the course of a three hours' search neither of them "could find a single plant of *Centaurea nigra* in the whole system." "It looks," he says, "as if Plowright's aecidium was possibly a unique departure—the beginning of a new adventure on the part of *P. Schoeleriana*." Even Plowright's "duplicated" cultures, few in number, can hardly be said to prove the distinctness of these two species of *Puccinia* against the evidence now available.

Uromyces Acetosae Schröt.

This Uredine is rather common on *Rumex Acetosa* and *R. Acetosella* in its uredo- and teleutospore stages. But I remarked in 1913 (*Rust Fungi*, p. 116) that the aecidium stage "has not been found in Britain." At Whitsuntide last year (June 4th) I was walking over Boniface Down near Ventnor, when my daughter, who was with me, brought me a leaf of *R. Acetosa* on which to my astonishment I saw an aecidium I had never seen alive before (Pl. XIX, fig. 3). On the same leaf were plenty of uredosori and further search found others of both kinds.

On examination, after returning home, I found the spores of both kinds to be according to the descriptions of the spores of *Uromyces Acetosae*. The uredospores were finely and densely verruculose, not sparsely aculeate, so that, though no teleutospores were present, the fungus could not be mistaken for *Puccinia Acetosae* Körn. The aecidia could be distinguished at sight by their yellow colour from those of *Puccinia Trailii* Plowr. (which through the kindness of Mr Ellis had been seen a few days before, on the same host, from Norfolk); the aecidium of this latter fungus has a pure white peridium (Pl. XIX, fig. 4). Moreover, the clusters of aecidia and the sori of uredospores were in contact on the same purple spots, evidently on the same mycelium. This, to me, unique occurrence in the fungus of a stage which appears to be not uncommon on the Continent, will make it very interesting to know what other uredinologists have experienced this spring.

The foregoing three uncommon aecidia of *Uromyces* discovered in May and June of last year cannot be treated as isolated phenomena.

They must have some connection with the weather which prevailed at the time. It is easily understood that the germination of the basidiospores of most of the Pucciniaceae is a matter of great delicacy; for the success of the operation the warmth and humidity of the atmosphere must be exactly suitable. No doubt the extraordinary warmth of the spring, accompanied as it was by dewy nights and sunny days, was unusually favourable. When reproduction by basidiospores fails to be effected, most Uredineae can propagate themselves by their uredospores, but then the aecidium will be missing from the cycle. Germinable uredospores of *Puccinia glumarum* can be found in fresh-formed sori on leaves of grass during a mild spell in January or February, and the same thing may be true of other Uredines even if they have a known aecidial form. We can therefore readily perceive that an aecidial stage may for years habitually fail to be produced, and yet in a given year may make its unexpected and welcome appearance.

Uromyces striatus Schröt.

It is well known to British uredinologists that the fungus on *Trifolium minus* which I described and illustrated under the name *Uromyces striatus* in my *Rust Fungi* in 1913 is not that fungus, but *U. Jaapianus* Kleb. The true *U. striatus* occurs chiefly on *Medicago* and has the warts of the teleutospores arranged more distinctly in straight lines so as to cause apparent striations.

Since that time Mr C. P. Hurst has sent me abundant specimens of a *Uromyces*, mostly with uredospores only, on *Medicago maculata* from Saltash, Cornwall, which cannot well be anything but *Uromyces striatus*. Specimens on the same host belonging to this species have been found in the Scilly Islands, and Mr J. C. Arthur has been kind enough to send me a teleutosporic specimen on *Medicago hispida*, from Penzance, collected by him during his visit to England in 1930. The same species is recorded by Mr Hadden, on *Trifolium procumbens* from north Devon, in the *Journal of Botany* (1916), p. 53. But I must confess that I cannot find on any of our British specimens such distinct striations as are displayed by those imported from the Continent.

Puccinia Luzulae-maximae Diet.

(In *Annal. Mycol.* xviii, 57)

Uredosori on yellowish indeterminate spots, which are brownish or rubiginous in the centre, hypophyllous, scattered, minute, long, covered by the epidermis which at length splits, cinnamon-coloured. Uredospores ovoid, ellipsoid, or subglobose, brown, echinulate, 23–40 × 17–29 μ, with two germ pores.

Teleutosori hypophyllous, like the uredosori in size or rather larger, somewhat compact, naked or still surrounded by the ruptured epi-

dermis. Teleutospores oblong-clavate or linear, subtruncate or rounded at the apex, where the wall is 6–12 μ thick, attenuated or rounded below, gently constricted, brown, smooth, 30–60 × 12–23 μ; pedicels persistent, up to 35 μ long; a few mesospores are found intermixed.

On leaves of *Luzula maxima* (only), Cotton College, North Staffs., and Llanspyddid, Brecon (Rhodes, No. 3559).

This supposed species has been found in Germany, Austria, and Switzerland. The average greatest length of the teleutospores on *L. maxima* is given as between 43 and 46 μ, while that of the species on *L. campestris* is given as 38–40 μ. I do not believe that Dietel's fungus is anything but a form of *Puccinia oblongata* Winter, which has been recorded on *Luzula maxima* many times in England.

Puccinia Cirsii-lanceolati Schröt.

(In *Pilz. Schles.* (1889), p. 317; Sacc. *Syll.* VII, 606; Jacky, *Composit.-bewohn. Pucc.* p. 46)

Caeoma Kabatianum Bubák, in *Sitz.-ber. Böhm. Ges. Wissen.* (1899) = *Gymnoconia Cirsii-lanceolati* Bubák, *ibid.*

Jackya Cirsii-lanceolati Bubák, in *Oesterr. Bot. Zeitschr.* (1902), p. 42.

Since the short note published in the *Journal of Botany* (1931), p. 195, did not describe this fungus completely, a full description and figure are now given here.

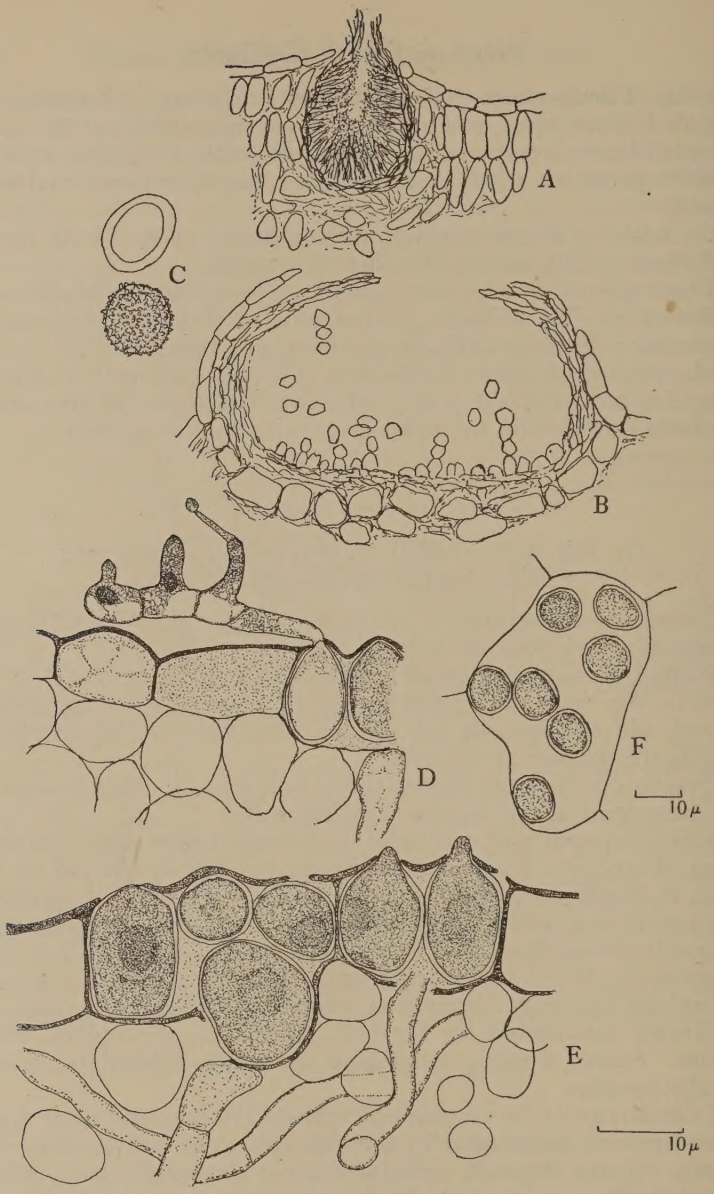
Pycnidia epiphyllous, flask-shaped, brownish, in little groups on the same spots as the aecidia (Text-fig. 2 A).

Aecidia hypophyllous, seated on small round yellow spots, scattered, often solitary, for a long time closed, then opening by a round median pore, at length broadly cup-shaped, whitish, with hardly a trace of any peridium (Text-fig. 2 B). Aecidiospores globose, subglobose, or ellipsoid, verruculose, pale orange, 22–35 × 20–28 μ, with a thick epispore (up to 2 μ), not remaining in long chains (Text-fig. 2 C).

Uredosori generally epiphyllous, scattered or often aggregated and confluent, surrounded by the cleft epidermis, pulverulent, ferruginous. Spores globose, subglobose, or ovoid, echinulate, brown, 24–26 × 20–28 μ.

Teleutosori generally epiphyllous, scattered or here and there aggregated, minute, surrounded by the cleft epidermis, pulverulent, dark brown. Spores ellipsoid, rounded but not thickened above, hardly or not at all constricted, rounded or gently attenuated below, punctate, obscure brown, 30–40 × 22–25 μ; pedicels short, hyaline.

On leaves of *Cirsium lanceolatum*. There is a possibility that it also occurs on *C. eriophorum*, for Jacky succeeded in transferring it from *C. lanceolatum* to *C. eriophorum*, but only in small quantity (*Centralbl.*



Text-fig. 2

Puccinia Cirsii-lanceolati Schröt. A. Longitudinal section through a pycnidium. B. Longitudinal section through an aecidium, showing that the wall is composed of ordinary mycelial hyphae. C. Aecidiospores, showing the very thick wall and its extremely warty exospore.

Melampsorella Symphyti Bubák. D. A basidium produced from a teleutospore within an epidermal cell of the host. E. Two infected epidermal cells containing teleutospores. Those on the right have just commenced to germinate. F. A tangential section of an epidermal cell, showing the several teleutospores it contains.

(D, E and F, microtome sections stained with haematoxylin.)

f. Bakt. u. Paras. II. IX (1902), 798). It is recorded from Mid and South-West Europe, and from North America.

I mentioned this species in my *Rust Fungi* (1913), but, as only the uredo- and teleutospores had up to that time been noticed on *Cirsium lanceolatum* in Britain, hesitated to include it in our flora. The reason why the aecidia had not been found is that they mostly occur, very fleetingly, only on the under side of the lower leaves of the Spear Thistle, often when these are in contact with the ground, and only in small numbers. But Dr Alex. Smith discovered them at Bourne, Cambridgeshire, in May, 1931, and also in Scotland. They were afterwards found in Norfolk, and in July, 1931, Dr P. G. M. Rhodes kindly took me to a locality in Worcestershire, near Evesham, where we found the aecidia, after some searching, in a damp tract of rough ground among trees and bushes. Dr Smith remarks that slugs are fond of eating out the infected spots, before the production of aecidia, possibly on account of the sweet liquid excreted by the pycnidia. If one considers how frequently the later stages are found on *Cirsium lanceolatum*, it may safely be surmised that the aecidia could be discovered in many other localities by looking for them with sufficient perseverance, at the right time, and in a suitable environment.

Melampsora euphorbiae-dulcis Otth

(In *Mitt. nat. Ges. Bern* (1868), p. 70)

[*Pycnidia* amphigenous, scattered among the caeomata, compressed globose, at first yellow, soon darker.

Caeomata amphigenous and on the stems, but more often hypophyllous, minute, orange. Caeomaspores more or less globose or ovoid, densely verrucose, pale golden, 22–28 × 20–24 μ; no paraphyses.] (Not yet found in this country.)

Uredosori mostly hypophyllous, scattered, connate and forming little round clusters, up to 500 μ diam., yellow. Spores more or less globose or ellipsoid, 15–23 × 12–20 μ; wall rather thick, echinulate, pale yellow; paraphyses numerous, capitate, 14–26 μ wide above, with rather thick walls.

Teleutosori amphigenous and on the stems, sub-epidermal, generally in dense groups, very small, clear-fuscous, finally darker. Spores ovoid or almost globose, but in tangential section becoming prismatic by mutual pressure, 18–40 × 7–15 μ, clear fuscous or somewhat darker, not thickened at the vertex.

On leaves and stems of *Euphorbia dulcis*.

This Uredine was collected at Glengariff in Ireland by the famous American mycologist, Mr J. C. Arthur, on August 29th, 1930, while he was on a visit to these islands for the International Botanical Conference, and he very kindly sent me a part of his collection.

Euphorbia dulcis is, presumably, an introduced species in Ireland. Its Rust is found in many parts of Europe, and not only on *E. dulcis*, but also on *E. Lathyris*, *E. pilosa*, *E. platyphyllos*, *E. stricta*, etc. This *Melampsora* is one of the many forms of the genus which sports so freely on *Euphorbia*, but it is very different from most of the others in its small and nearly globose teleutospores.

Melampsorella Symphyti Bubák

Formerly this fungus was known in Great Britain only in the uredospore stage and usually only on *Symphytum officinale* (Grove, *Rust Fungi*, p. 363). During the Spring Foray of the British Mycological Society to Ludlow in May, 1932, the teleutospores were discovered by Dr Alex. Smith.

On this occasion the teleutospores were found on the leaves of plants of *Symphytum peregrinum* (*S. asperrimum*) which were growing at the edge of a wood in Boyne Park, about ten miles from Ludlow. Trees of *Abies pectinata*, the alternate host of this *Melampsorella*, were growing in the vicinity. Very few of the plants of *Symphytum* bore teleutospores and only the older leaves were infected with this stage. Repeated visits to the locality have failed, so far, to discover any aecidia on the *Abies*.

The teleutospores are hypophyllous and arise on the same mycelium that bears uredospores but at a later stage of growth. Usually they occupy the areas of the leaf surface between the uredosori and form pinkish or puce-coloured crusts which contrast strongly with the rather pale green of the leaf and also with the pale yellow uredosori.

Several teleutospores occur in each epidermal cell (Text-fig. 2 F). They are hyaline or slightly yellowish when mature, spherical or ovoid, and measure about $10–18 \times 8–12\,\mu$. The wall is rather thin and shows no well-defined pore except at the time of germination (Text-fig. 2 E). Apparently germination occurs without any lengthy resting period and I have frequently observed basidia in nature during late May and the early part of June of 1932 and 1933. At other times incubation of from 12 to 24 hours in a moist chamber is sufficient for their production. On germination the apical end of the spore elongates and the basidium bursts through the end of the papillate projection which has pierced the outer epidermal wall. Frequently all the teleutospores in one epidermal cell germinate at once (Text-fig. 2 E) and the epidermal wall is destroyed to such an extent that the teleutospores may be displaced and lie free on the leaf surface. The basidia are rather thick and short and give rise to four spherical or pear-shaped basidiospores $4–4{\cdot}5 \times 3{\cdot}5–4\,\mu$ in size which are formed on long tapering sterigmata (Text-fig. 2 D). In moist weather out of doors the teleutospore crusts are covered by

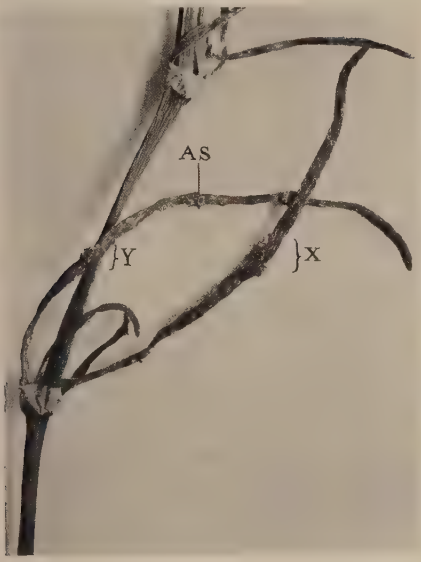


Fig. 1

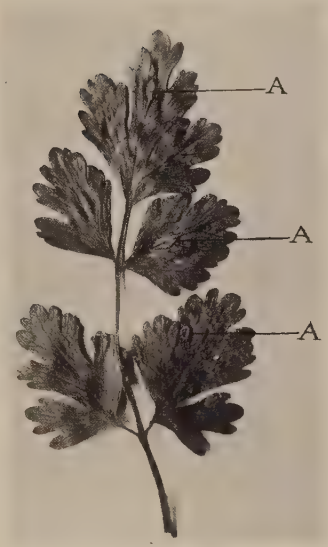


Fig. 2

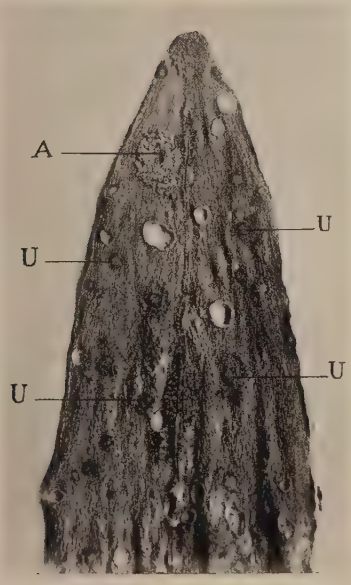


Fig. 3

Fig. 4

masses of intertwined basidia and in this condition they become almost white in colour.

Melampsorella Symphyti is frequently found in the Midland Counties on *Symphytum officinale*, but only the uredospores are, so far, known upon that host. Probably the occurrence of the teleutospores at Boyne Park is due to the favourable site and further search may yet discover the aecidial stage in that area.

EXPLANATION OF PLATE XIX

Fig. 1. *Uromyces sparsus* Lév. A portion of a plant of *Spergularia marina* infected with the fungus, showing aecidial sori (*AS*). The region marked *X* has been enlarged in Text-fig. 1 A and bears a uredosorus and two aecidial sori. At *Y* (see also Text-fig. 1 C) a young aecidial sorus occurs; the white spots represent nectar extruded from the mouths of the pycnidia.

Fig. 2. *Uromyces Scirpi* Burr. Leaflets of *Oenanthe crocata* bearing aecidial sori (*A*) of this fungus.

Fig. 3. *Uromyces Acetosae* Schröt. The apical portion of a leaf of *Rumex Acetosa* bearing aecidial sori (*A*) and uredosori (*U*) of this fungus. The brilliant red areas on which the sori are situated are not shown distinctly in the photograph and the same remark applies to Fig. 4.

Fig. 4. *Puccinia Trailii* Plowr. For comparison with Fig. 3; a portion of a leaf of *Rumex Acetosa* bearing sori whose aecidia are almost pure white in colour in contrast to the rich yellow of those of *Uromyces Acetosae*.

(Figs. 1, 3 and 4 are photographed at the same magnification, Fig. 2 is slightly reduced.)